The Models Used by Elementary School Teachers to Solve Verbal Problems

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Abstract: One of the most important goals of mathematics education is to improve students' problem solving skills, which can only be realized by teachers who are well-trained in this field. In this context, the purpose of the studies on the subject is to investigate the models used by elementary school teachers to solve verbal problems and their opinions in this process. A multiple-case study was conducted for this study which employs the Problem Information Scale comprised of eight open-ended questions. The study sample consists of a total of 100 elementary school teachers. Six of them were selected for individual interviews on the basis of theoretical sampling. The data obtained revealed that the elementary school teachers experienced problems with students aged from 7 to 11 in the use of models to solve verbal problems and they make mistakes by assigning values and replacing variables such as x, y, a with shapes such as , Δ in the problem equation, instead of using models to solve problems.

Introdunction and Theoretical Background

Improving students' problem solving skills is one of the most important aim of mathematics education. While solving problems students not only use their mathematical knowledge they already gained but also improve their knowledge and understanding leading them to a better mathematical insight (Çamlı and Binbaşı, 2009; Okur, Tatar and İşleyen, 2006; Williams, 2003; Olkun and Toluk, 2002; Schoenfeld, 2002; Taplin and Chan, 2001; National Council of Teachers of Mathematics, 2000; Jonassen, 2000; Roth, and McGinn, 1997; Reusser and Stebler, 1997). Therefore, problem, the structure of problem solving, and improving success in problem solving have been investigated by many educators (Kılıç and Samancı, 2005). Recent curriculum reforms in some Australian states (e.g. Department of Education Tasmanian, 2002) have highlighted the importance of thinking, communicating and instilling deep understanding in our students and have seen a re-emphasis on mathematical problem solving as an important mechanism for enhancing these skills. Problem solving is, of course, not a new idea in mathematics education. Over half of a century ago, the importance of problem solving was recognized (Brownell, 1942, cited in Suydam, 1980) and its importance was emphasized strongly throughout the 1980's (Suydam, 1980). Polya (1957) and others (e.g. Branca, 1980; Schoenfeld, 2002) maintain that problem solving is the goal of mathematics learning while the NCTM(2000) go further saying that problem solving "is not only a goal of learning mathematics but also a major means of doing so" (Beswick and Muir, 2004). As problem solving has increasingly become more important in

mathematics education, the importance of examining problem solving processes and teachers' approaches toward these processes regard has also increased. The attempts at reforming curricula and mathematics education have frequently underlined the need to integrate problem solving into all grades and every mathematical subject. Therefore, teachers' perceptions of problem solving processes and their beliefs about problem solving have become a significant research subject (Kayan and Çakıroğlu, 2008).

Problem solving should not be simplified by reducing it to simply answering a mathematical question. Problem solving is a way of thinking; it requires reconsidering what is learned and using it in all mathematical activities (Barb and Quinn, 1997). It is asserted that the solution of a problem depends not only on the calculation skill, but also on specific types of knowledge (domain-specific knowledge). The studies in the literature define the types of knowledge as linguistic/factual knowledge, schematic knowledge, algorithmic knowledge, and strategic knowledge and underlines that individuals should possess these types of knowledge to solve a problem (Karataş and Güven, 2003). As only calculation skill, i.e. operational knowledge is highlighted in the process of problem solving; students are observed to fail in the problems that require comment and analysis. It is observed that students do not usually experience much difficulty with standard problems which can be easily solved using basic operations without the need for any strategic formulation, but they have difficulties with problems that cannot be solved quickly using mathematical operations and require mathematical models and interpretation (Soylu, 2007a; Soylu, 2007b). To ensure meaningful learning in mathematics, while teaching the lesson, we need to attach importance to the use of problems that could help students understand the concepts concerning the subject, see the operations taking place between these concepts, and establish connections between concepts and operations (Soylu and Soylu, 2006). As a matter of fact, for Cognitive theorists, comprehension and understanding occupy a significant place in problem solving (Slavin, 2008). When the presence of such difficulties is obvious in problem solving, studies have revealed that by clearly identifying the process of problem solving and applying suitable teaching techniques, children can acquire problem solving strategies (Koray and Azar, 2008; Özkök, 2005; Yazgan and Bintaş, 2005).

Mathematics is a lesson involving abstract concepts and the relations between these concepts. Abstract concepts are usually difficult to be acquired by students in the concrete operational stage. However, this difficulty could be overcome by concretizing the abstract concepts of mathematics during instruction (Baykul, 1999). Petit and Zowojewski (1997) point out in their study that a teacher should employ the appropriate method and techniques to facilitate problem solving. A child's cognitive development should be taken into account when determining these techniques. Primary school teachers should perform problem solving activities by taking into account their students' cognitive development. They should use concrete activities and models more at primary school level since they teach students who are in the concrete operational stage (7-11 years) (Albayrak, 2000). A child cannot be directly introduced to a mathematical concept. Instead, s/he should be presented with the concept by way of using mathematical models. Thus, the child can construct this mathematical concept in his/her mind by performing some operations on these models. The model for a mathematical concept could be a picture, a drawing, a symbol or a concrete instrument that contains the relationship that this concept conveys. Teacher' should duty to concretize abstract concepts by way of using various models. A multiple number of different models should be employed when concretizing abstract concepts. The highest level of conceptual understanding will be achieved when students learn a concept using multiple models. If we let students experience the same concept using different ways and under different circumstances, but within a similar structure, they will discover that the

concept does not depend on a single physical model and thus isolate the common characteristics of these experiences (Olkun and Toluk, 2004). However, many teachers complain that they cannot solve problems without using equations since they become used to solving problems using equations during their high school and university years. It is not sufficient for a teacher to solve a given problem using equations. He or she should also be able to explain the solution of the problem to his or her students by drawing shapes or schemas without using equations. It is not suitable for the cognitive development of elementary-level students to solve a problem using equations by replacing the unknown value with a variable such as x, y, a or b. Sometimes, teachers might reflect their own problem solving techniques to their students. Thus, teachers should get accustomed to problem solving methods that are suitable for the cognitive development of their students. It might at times seem impossible to a teacher to solve a basic operations problem without equations (without using algebra); however, it is a fact that all the basic operations problems at elementary school level can be solved by drawing suitable shapes or schemas (Tatar, Okur and İşleyen, 2005).

In accordance with these studies, this study aims to identify the models and the approaches used by elementary school teachers while solving verbal problems. The motive behind conducting the present study has been to determine the positive and negative approaches displayed by elementary school teachers while solving verbal problems and whereby to inform them about these approaches. By informing teachers about it, it is aimed that they will replace their current negative approaches displayed when solving verbal problems with positive approaches. Thus, teachers' use of such positive approaches when solving verbal problems will positively contribute to students' abilities to solve verbal problems.

Under this theoretical framework, this study attempts to answer the following research questions:

- What are the approaches and models used by elementary school teachers to solve verbal mathematical problems?
- Are the approaches and models used by elementary school teachers to solve verbal mathematical problems appropriate for students to achieve competency in this field that problem solving skills?

Method

This study uses the case study method where the models used by elementary school teachers to solve verbal problems are inquired with interview and writing samples.

Sample

In order to identify the models and approaches they use to solve verbal problems, a sample group consisting of elementary school teachers was formed. The sample group consists of 110 primary school teachers who volunteered to participate in the study after having one-to-one interviews with the researcher. In selecting the sample, care was taken to select primary school teachers who have taught all the grades at the first elementary level (grades 1, 2, 3, 4, and 5) since the questions in the Problem Information Scale (PIS) used to collect data concern different grade levels. Furthermore, since the 2000s, the practice of teaching first-level elementary mathematics lessons using activity-based or concrete models as opposed to the conventional teaching method

has become prevalent in Turkey. Therefore, the primary school teachers' professional experience was limited to 10 years, mainly because primary school teachers with a maximum professional experience of 10 years did not take any courses about mathematics teaching during their university education. The participants were randomly selected from among the teachers who met the above conditions. The study was conducted during the second semester of the academic year 2008–2009.

Data Analysis

The Problem Information Scale prepared by the researcher was used to identify the models and approaches used by elementary school teachers to solve verbal problems. The (Tatar, Okur and İşleyen 2005) study was used while preparing the Problem Information Scale (PIS). The PIS assumed its final shape after it was evaluated by two instructors with expertise in the field and three elementary school teachers in terms of level, scope, content and language. The PIS consists of eight verbal problems that do not require the use of equations to solve at the first level of elementary school. The pilot study of the instrument was first carried out on fifteen teachers. Following the pilot study, the 10-question PIS was transformed into an eight-question scale in accordance with the teachers' responses and this final version was used in the study. The first and second problems are about numbers and shopping; the third and fourth are age problems; the fifth and sixth are velocity problems; and the seventh and eighth are fraction problems, all of which asses teachers' ability to solve problems without using variables. Teachers' responses were evaluated and analyzed using the frequency method. In order to identify more clearly the models used and the mistakes made by elementary school teachers while solving verbal problems, written responses of 9 teachers are quoted and interviews individually carried out with 6 teachers are included.

Process

The scale developed by the researcher was administered to the elementary school teachers in one hour. The teachers were asked to solve these questions using area, length, number, etc. models instead of equations and write down their comments in the blank fields for responses on the test sheets. Furthermore, interviews were conducted to reveal the attitudes and views displayed by the teachers while solving verbal problems. No help was offered during the application process.

Findings

This section contains the responses provided by the elementary school teachers to eight open-ended questions, as well as the interviews carried out with some of the teachers and their answer sheets.

Categories of responses	Frequencies
The question was answered using any model (shaded area, length, etc.).	13
The question was answered using variables such as x, y, a, etc.	41
The question was answered using random numerical values.	13
The question was answered using only subtraction and division without providing any explanations.	11
Other answers	6
Unanswered	16

Table 1. Elementary school teachers' responses (frequencies) to question 1 in the questionnaire (N=100)

Table 1 reveals that while solving the first problem, the elementary school teachers failed to use certain models suitable for the first level of elementary school and that they solved this problem by using variables that are not appropriate for this level. Furthermore, the elementary school teachers stated that they solved the problems by subtraction and division and without using equations; yet, they did not provide any explanations. The response of and the interview with one of the teachers who solved the problem this way is presented below.
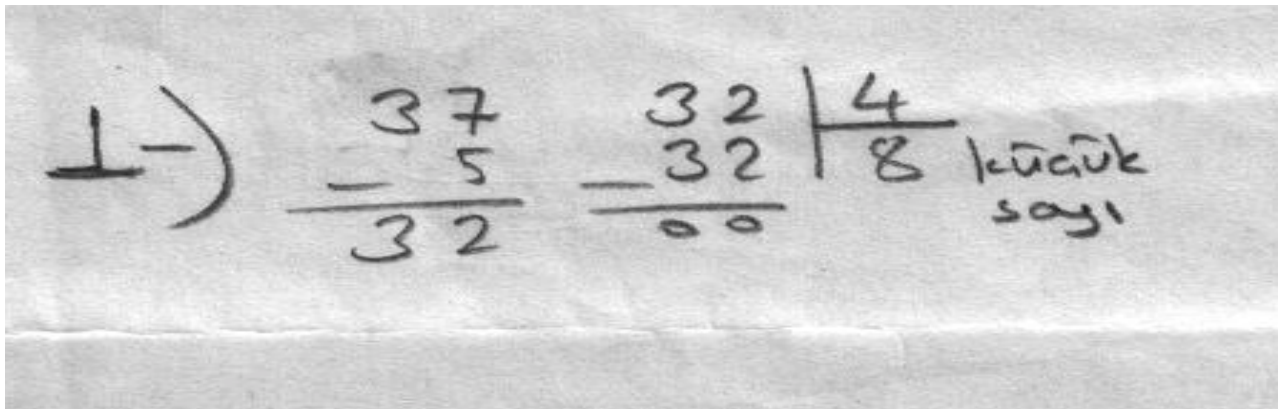

Figure:1. Teacher I's response for question

Researcher: While answering the first question, you subtracted 5 from 37 and divided the result by 4 to reach the solution. The result is correct, but how can you explain to your students the reason why you have carried out these operations?
Teacher I: I make sure that they understand I carried out the subtraction operation as there is an excess and the division operation as the number is multiplied.
Researcher: So, you identify some operations with some concepts.
Teacher I: Yes, there is no other option. If you use variables, the students will not understand.
Researcher: While solving a problem, is it possible to use area, length, etc. Models in a way that can be understood by the students?
Teacher I: It is possible. However, when models such as shaded area are used for all problems, we cannot have the students practice enough.

Categories of responses	Frequencies
The question was answered using any model (shaded area, length, etc.).	7
The question was answered using variables such as x, y, a, etc.	37
The question was answered using random numerical values	10
The problem is solved considering the price of the extra two pencils is 10 TL.	11
After setting up the equation with variables such as x or y, the problem is solved by replacing these variables with shapes such as □, Δ.	17
Other answers	5
Unanswered	13

Table 2. Elementary school teachers' responses (frequencies) to question 2 in the questionnaire (N=100)

Table 2 displays that while solving the second problem, the elementary school teachers did not take into account the fact that their students are in concrete operational stage. Just as they did in the first question, they are observed to have assigned to the variables not only special values, but also variables such as x, y or shapes such as □, Δ in the equation. During the interviews, the teachers claimed that they solved the problems without using variables when they replaced variables such as x, y or a with shapes such as □, Δ. The response of and the interview with one of the teachers who solved the problem this way is presented below. In addition, to fulfill one aim of the research, which was to inform the teachers about the matter, a correct response reached using the shaded area model is also presented.
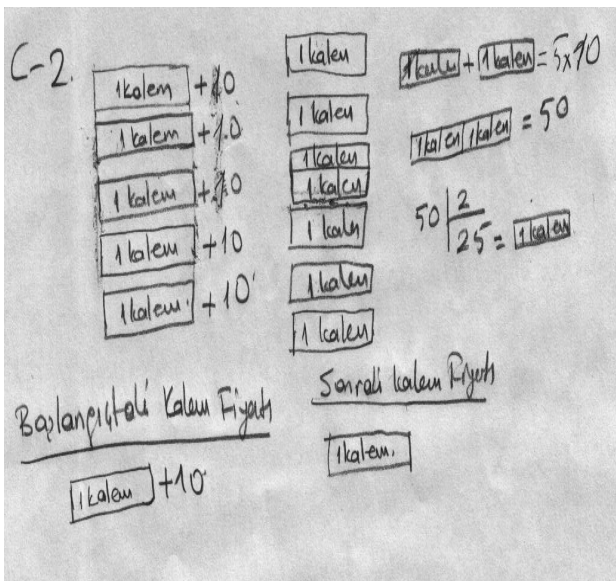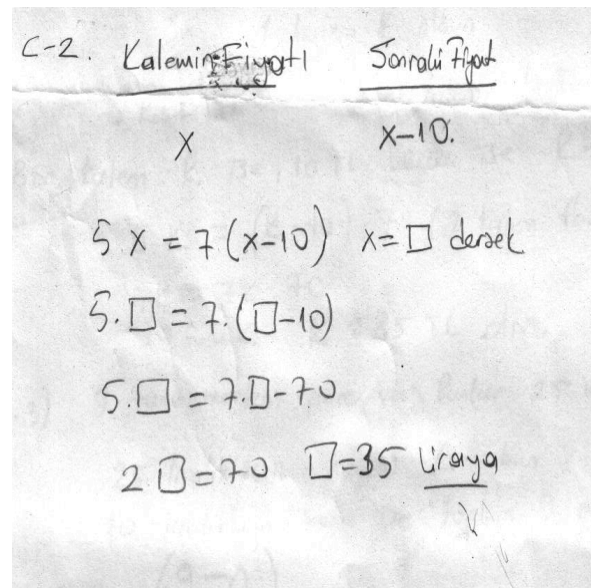

Figure:2.Solution without variable of question 2

Figure:3. Teacher II's response for question 2

Researcher: You replaced x with shape Δ in the equation 5x=(x-10).7 to solve the problem. Why did you feel the need to replace the variable with a shape?
Teacher II: As students at the first level of elementary school are in concrete operational stage, they cannot make sense of the variable x. So I replaced it with shape Δ.
Researcher: Then, when variables such as x, y, a, etc. are replaced with certain shapes, the solution of the problem is simplified enough for the students to understand. Is that correct?
Teacher II: Of course, that is correct. Shapes are both meaningful and interesting for students.

Categories of responses	Frequencies
The question was answered using any model (shaded area, length, etc.).	32
The problem is solved using the concept of multiples. (3 multiples+1 multiples=20)	16
The question was answered using variables such as x, y, a, etc..	13
The question was answered using random numerical values.	7
After setting up the equation with variables such as x or y, the problem is solved by replacing these variables with shapes such as □, Δ.	21
Other answers	7
Unanswered	4

Table 3. Elementary school teachers' responses (frequencies) to question 3 in the questionnaire (N=100)

As seen in Table 3, the rate of solving the age problem in a suitable manner for first-level elementary school students was higher than the rate in the first and second problems. Although the first and third problems have exactly the same structure, the rate of using a model in the third problem was higher than in the first problem. The interview with a teacher who solved the first problem by using equations and the third one by using the length model revealed that they limited the use of models to certain problems. The response of and the interview with one of the teachers who solved the problem this way is presented below
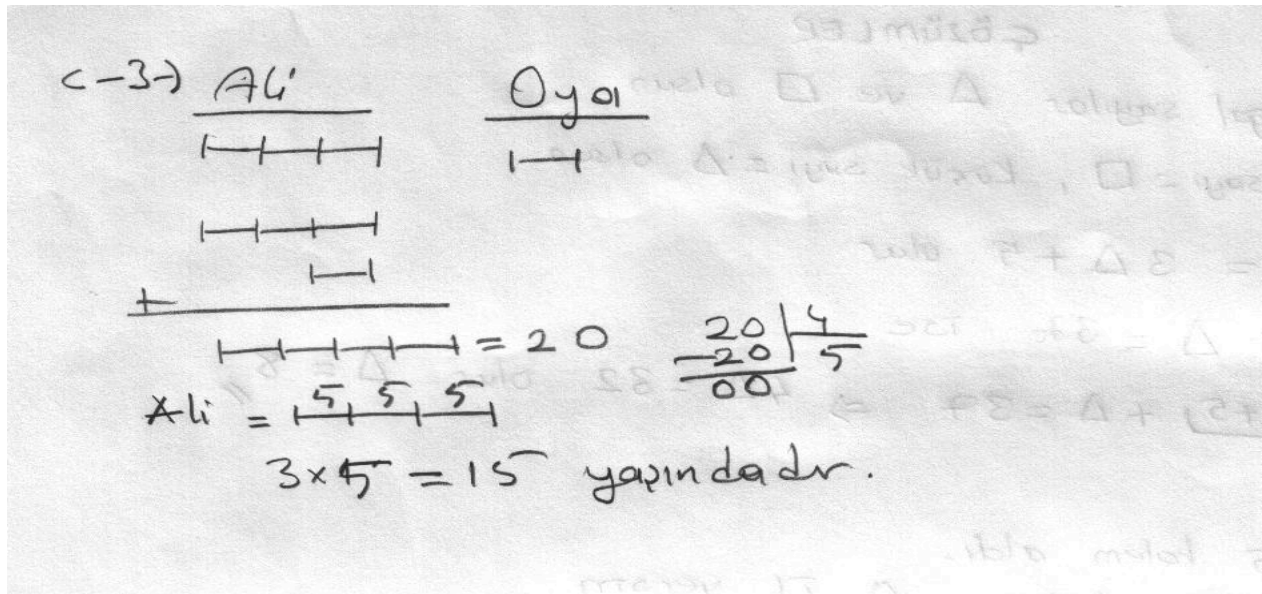

Figure:4. Teacher III's response for solution without variable of question 3

Researcher: Although you solved the first problem using the variable x, you used the length model for the third one which has the same structure as the first. Why did you take two different ways to solve two similar-structured problems?

Teacher III: The reason might be that fraction and age problems are suitable for using shapes such as the shaded area and length. I mean, it is easier to use shapes for age and fraction problems.

Researcher: Do you think that models such as area, length, etc. should be used for specific problems such as fraction and age problems?

Teacher III: Not exactly, but I think it is more appropriate to use these models for these kinds of problems.

Categories of responses	Frequencies
The question was answered using any model (shaded area, length, etc.).	4
The question was answered using variables such as x, y, a, etc..	24
The problem was solved by assigning values for each year..	37
After setting up the equation with variables such as x or y, the problem is solved by replacing these variables with shapes such as □, Δ.	11
Other answers	7
Unanswered	17

Table 4. Elementary school teachers' responses (frequencies) to question 4 in the questionnaire (N=100)

As seen in Table 4, the rate of solving the fourth problem in a suitable manner for the first-level elementary school students is quite low. Although such problems usually require generalizations and teaching students a specific method, the responses reveal that value assignment method was predominantly used. The interview with a teacher who used value assignment method shows that he believes the problems for the first level of elementary school are appropriate for the value assignment method. The response of and the interview with one of the teachers who solved the problem this way is presented below. Furthermore, to fulfill one aim of the research, which was to inform the teachers about the matter, a correct response reached using the shaded area model is also presented.

Figure:5. Teacher IV's response for question4   Figure:6. Solution without variable of question2

Researcher: You solved the fourth problem by assigning values. Is this way of solution a correct method for all problems of this kind?

Teacher IV: It is essential to solve problems without using variables such as x or y in the first level of elementary school. As no variables are used in this way of solution, I think it is a correct method.

Researcher: If the answer were not 3 years, but 25 years, do you think this method would still be correct? I mean, is it correct to assign a value 25 times?

Teacher IV: The problems of that kind are not asked to students at the first level of elementary school. When they are asked to students at the second level, it is suitable to use variables in the solution.

The data in Table 5 reveals that the teachers did not experience much difficulty while solving the fifth question without using variables. Thirty five teachers in the sample solved the problem by drawing an appropriate shape for the problem and 36 solved it without shapes and variables; that is to say, at a level appropriate for the students at the first level of elementary school.

Categories of responses	Frequencies
The problem was solved without variables by drawing appropriate shapes for the problem.	35
The question was answered using variables such as x, y, a, etc..	13
The problem was solved by proportion.	9
The problem was solved without variables by calculating the total distance covered by the two vehicles in 6 hours.	36
Other answers	5
Unanswered	2

Table 5. Elementary school teachers' responses (frequencies) to question 5 in the questionnaire (N=100).

Categories of responses	Frequencies
The question was answered using any model (shaded area, length, etc.).	11
The question was answered using variables such as x, y, a, etc..	28
The problem was solved without using any models and variables through knowledge about velocity problems and basic operations.	12
The problem was solved y considering that the vehicles travel in opposite directions.	23
The problem was solved by assigning a value.	10
Other answers	2
Unanswered	14

Table 6. Elementary school teachers' responses (frequencies) to question 6 in the questionnaire (N=100)

As demonstrated by Table 6, the rate of solving the sixth problem in a suitable manner for the first-level elementary school students is quite low. Eleven teachers arrived at the correct result by drawing an appropriate shape for the problem, while 12 teachers solved the problem correctly without using any equations, shapes or models only by using their knowledge about velocity problems and basic operations. Twenty three teachers confused the solution to this problem with the solution to the fifth question. The interview with one of the teachers who made this mistake revealed that in velocity problems, generalizations regarding the directions are memorized. The response of and the interview with one of the teachers who solved the problem this way is presented below. Furthermore, the response of a teacher who solved the problem by assigning a value is included.
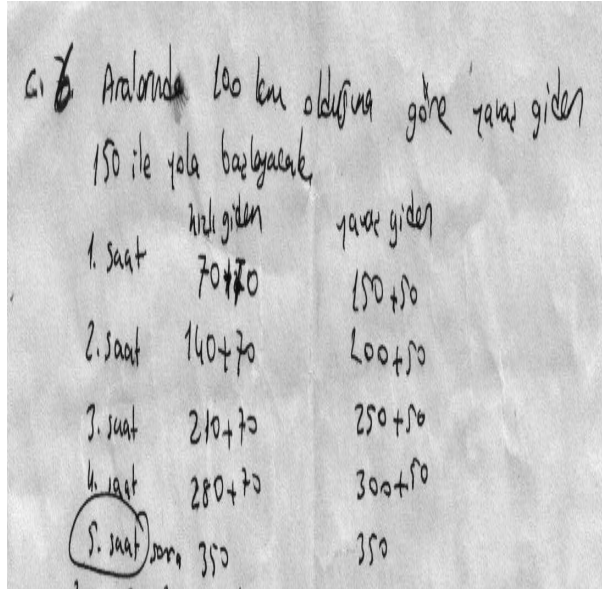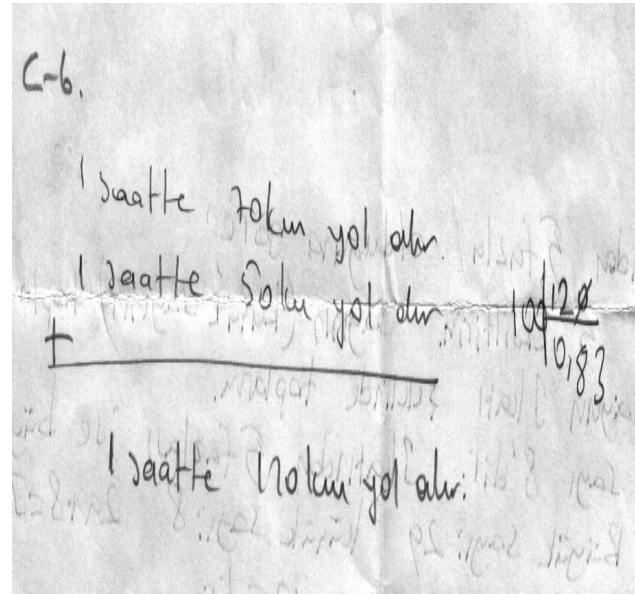
Figure:7. Teacher V's response for question 6.   **Figure:8. Teacher V's response for question 6.**

Researcher: While solving the problem, you calculated the total distance covered by the vehicles in an hour and divided the distance between the two cities by this number. Can you tell us why you solved the problem this way?

Teacher V: I am not very good at velocity problems. I know that the division of the total distance that the vehicles cover in one hour by the distance between the cities gives the correct result.

Researcher: These operations are done when vehicles move towards each other. But in this problem the vehicles move in the same direction.

Teacher V: Right, when they travel the opposite direction, addition is done, if they travel in the same direction, subtraction is done. I confused the directions.

Researcher: While teaching velocity problems to the students, is it correct to provide them with rules depending on the direction?

Teacher V: I remember that it generally produces the correct result. Thus, it is suitable to present as a rule generalizations depending on the direction.

Categories of responses	Frequencies
The question was answered using any model (shaded area, length, etc.).	36
The question was answered using variables such as x, y, a, etc..	17
After setting up the equation with variables such as x or y, the problem is solved by replacing these variables with shapes such as □, Δ.	12
The problem was solved by using basic operations in fractions without using any models or equations.	14
Other answers	9
Unanswered	12

Table 7. Elementary school teachers' responses (frequencies) to question 7 in the questionnaire (N=100).

As seen in Table 7, thirty six teachers in the sample used the shaded area model, while 14 teachers used basic operations in fractions, thus solving the problem in a way suitable for the level of 7-11 age group without using variables. When the responses provided in the PIS by the teachers in the sample are considered, it is observed that the most frequent use of models appear

in the solution of this problem. In an interview with a teacher who solved the fifth problem of the PIS using variables, the teacher stated that he formed the habit of solving fraction problems using the shaded area model in secondary school years and that he could easily solve such problems using this method. It is evident from this interview that teachers cannot easily outgrow the habits that they formed in their secondary school years. The response of and the interview with one of the teachers who solved the problem this way is presented below.
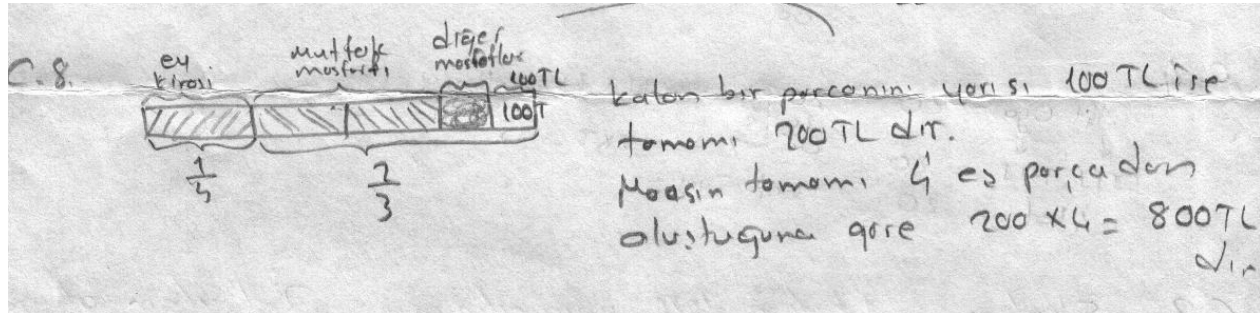

Figure:9. Teacher VI's response for solution without variable of question 7

Researcher: Even though you used variables to solve the second problem, you used the shaded area model to solve this one. What can the reason for these different solutions?
Teacher VI: As I formed the habit of solving fraction problems using the shaded area model in secondary school, I do not have much difficulty with using this method.
Researcher: Apart from fraction problems, what is your reason for solving basic operations problems using variables?
Teacher VI: When I was a student, I used to solve such verbal problems using variables all the time. I guess I cannot outgrow this habit. I try to demonstrate a problem using the shaded area but when I cannot do it, I resort to setting up equations with variables at once. But I use models for fraction problems because the structure of such problems is appropriate for using the shaded area model or other models.
Researcher: It is essential to take into account the concrete operational stage while teaching students at the first level of elementary school. Thus, variables should not be used to solve problems. What do you think about it?
Teacher VI: I take into account the concrete operational stage while teaching these classes. While solving problems with my students, I make use of a model if I can. If I cannot, I solve it using variables rather than leaving it unsolved.
Researcher: But when you solve it using variables the students will not understand. Do you think it is logical to solve this knowing this fact?
Teacher VI: You cannot leave it unsolved.

Categories of responses	Frequencies
The question was answered using any model (shaded area, length, etc.).	16
The question was answered using variables such as x, y, a, etc..	27
After setting up the equation with variables such as x or y, the problem is solved by replacing these variables with shapes such as □, Δ.	9
The problem was solved by using basic operations in fractions without using any models or equations.	14
The question was answered using random numerical values.	7
Other answers	8
Unanswered	19

Table 8. Elementary school teachers' responses (frequencies) to question 8 in the questionnaire (N=100).

As seen in Table 8, sixteen teachers in the sample used the shaded area model, while 14 teachers used basic operations in fractions to solve the model without using variables. Though this problem is a fraction problem like the seventh problem, obviously, the rate of using a model in this problem decreased from 36 to 16. In parallel, the rate of using variables to solve the problem increased. When teachers face a somewhat complicated problem, they are observed to prefer using variables instead of certain models to solve these problems.

Discussion and implications

According to Piaget's stages of cognitive development, students at the first level of elementary school (7-11) are in concrete operational stage. Therefore, teachers who teach the first level of elementary school should bear in mind the characteristics of concrete operational stage while solving problems. To enable the students in concrete operational stage to make sense of problems, one should not use variables such as x, y or a or operations that are not meaningful for them. Problems should be solved by using concrete models (area, length, volume, shape, picture, concrete object, etc.) instead because in this period children can only solve complex problems using concrete models. However, they cannot solve abstract problems (Senemoğlu, 1997). Though this fact is evident, the data obtained in the study demonstrates that while solving problems, elementary school teachers cannot sufficiently make use of models that are appropriate for students in concrete operational stage, and on the contrary, resort to solutions using variables (algebra). These results are similar to the findings of others studies such as (Tatar, Okur & İşleyen 2005; Greer 1997).

In the light of the data obtained in the findings section of this research, it might be stated that while solving verbal problems in the first level of elementary school, elementary school teachers are not skilled enough to use models that are appropriate for the students' level. This lack of skill is revealed in many ways. The first one is the idea that the problem is solved without equations and using models when variables such as x, y or a are not used in the solution of the problems. This situation was more clearly observed in the interview with a teacher who solved the second problem in this way. During the interview, the teacher explained the reason why he

replaced x with the shape Δ in the equation 5x=(x-10).7 and thus transformed the equation into 5.Δ=(Δ-10).7 while solving the second question by stating that there was no variable x in the equation. He asserted that as the solution did not include the variable x, it is appropriate for first-level elementary school students. This shows that teachers have the misconception that replacing variables such as x, y or a with shapes such as Δ, □ means solving the problem without variables.

Another reason why teachers cannot sufficiently use models in problem solving is that they limit the use of models to a certain group of problems. Given the primary school teachers' responses to the verbal problems, the questions in which the models were most frequently used were questions 7 (33%), 5 (31%) and 3 (30%). Although the rates were so low, the teachers were asked about why they used models in these questions and they responded that these problems were appropriate for modeling. This is clear in the solution of the first and third problems which have similar characteristics. While thirteen elementary school teachers used models in the solution of the first problem, this rate increased to thirty two in the solution of the third one. They asserted that the reason is that using area or length models is easier and more appropriate for age and fraction problems. This confirmed by the fact that thirty six teachers used models in the solution of the seventh problem. These results show that teachers limit the use of models to a certain group of problems.

The data analysis reveals in the findings section displays that a considerable number of teachers use the value assignment method. However, this method, does not occupies a distinctive place in problem solving or proving an expression in mathematics. This can be clearly observed in the solution of the fourth problem. Thirty seven teachers solved this problem by assigning a value. In the interview with a teacher who solved this problem by assigning a value revealed that he believed the problems in the first level of elementary school are suitable for the value assignment method. Apparently, he wrongly assumes that the problems which are not suitable for this method should be used in the second level of elementary school.

Teachers also have some deficiencies in the solution of velocity problems. It is observed that they made use of memorized knowledge that depends on the direction of vehicles while solving such problems. This is evident in the solution of the sixth problem. In an interview about this problem, a teacher stated that when the vehicles travel in the same direction, subtraction is done and if they travel in the opposite direction, addition is done. Teachers assert that they present to their students the memorized rule that either subtraction or addition operation is carried out in velocity problems, rather than teaching the rule in a meaningful context.

This study sought the answers to the following questions: "What are the approaches and models used by elementary school teachers to solve verbal problems?" and "Are the approaches and models used by elementary school teachers to solve verbal problems sufficient for students to achieve competency in this field?" In view of the obtained data, it was observed that the primary school teachers could not adequately use the models suitable for their students' levels while solving problems for students in the concrete operational stage. Arguably, primary school teachers who fail to use the models suitable for their students' levels in problem solving may have difficulty in improving their students' problem-solving abilities.

It was observed during the interviews with the primary school teachers that they attributed the reason why they used or did not use models when solving verbal problems to the education they received or the habits they acquired during their school years. For instance, they stated that the use of models in question 7, which concerns fractions, and the use of variables in question 2 resulted from their habits during their school years. Therefore, while teaching the unit on problem solving in mathematics courses, in addition to providing the students with theoretical

knowledge, it is essential to demonstrate practically to them how models such as area, length, volume, etc. are used to solve problems.

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Appendix: Questions used in questionnaire and interviews

1. The sum of two natural numbers is 37. The greater number is 5 more than three times the smaller number. What is the smaller number?
2. Ali bought 5 pencils from the store. If he had bought one pencil for 10 TL cheaper, he could have bought 2 more pencils. So how much did Ali pay for a pencil?
3. The sum of Ali and Oya's ages is 20. Ali is three times Oya's age. How old is Ali?
4. Cem is 42 years old. Cengiz is 12 years old. How many years from now will Cem be three times as old as Cengiz is right now?
5. Two vehicles start moving at the same time towards each other. One of the vehicles travelling at 45 km/h begins moving from City A and the other one travelling at 65 km/h begins moving from City B. If these two vehicles meet 6 hours later, what is the distance between City A and B?
6. Suppose a truck leaves Erzurum, which is about 100 kilometers (km) from Erzincan at 10:00 am driving 70 kilometer per hour (kph) towards Ankara. At 10:00 am a bus leaves from Erzincan driving at 50 kilometer per hour (kph) toward Ankara. How many hours later will the truck catch up with the bus? (The bus and truck are going in the same direction)

7. A government officer allocates the $1/4^{th}$ of his salary for the rent and spends the $2/3^{rd}$ of the rest for kitchen expenses. After he spends half of the remaining sum for other expenses, he has 100 TL left. So how much is the salary of this officer?

8. $1/6^{th}$ of a pitcher is full of water. If 10 glasses of water is added into this pitcher, $1/3^{rd}$ is full. So how many glasses of water did the pitcher contain at the beginning?

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